EFFICIENT TECHNIQUE FOR ESTIMATING ELEVATION ANGLE
WHEN USING A BROAD BEAM FOR SEARCH IN A RADAR
Eli Brookner
Application No. 10/683,507

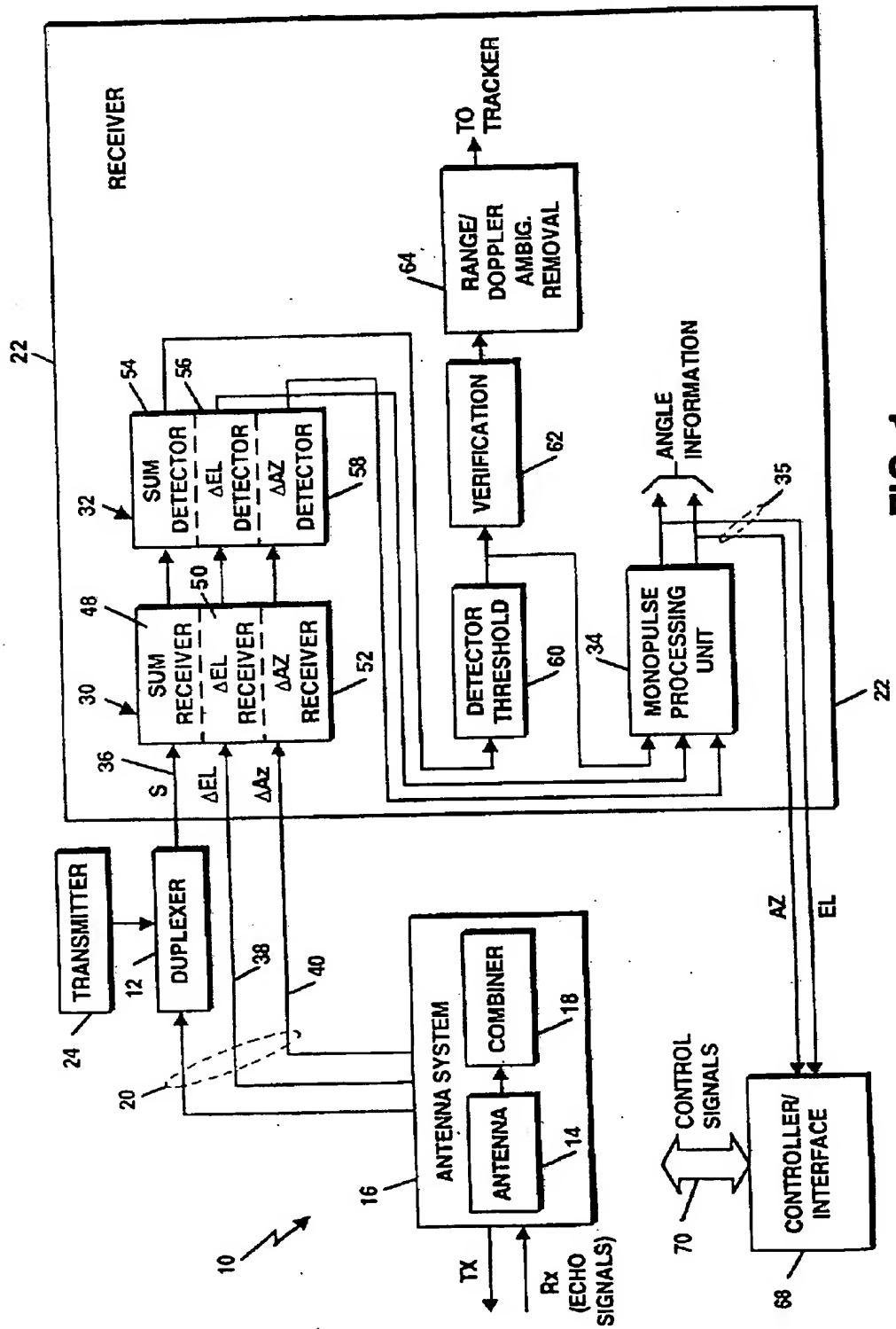

FIG. 1

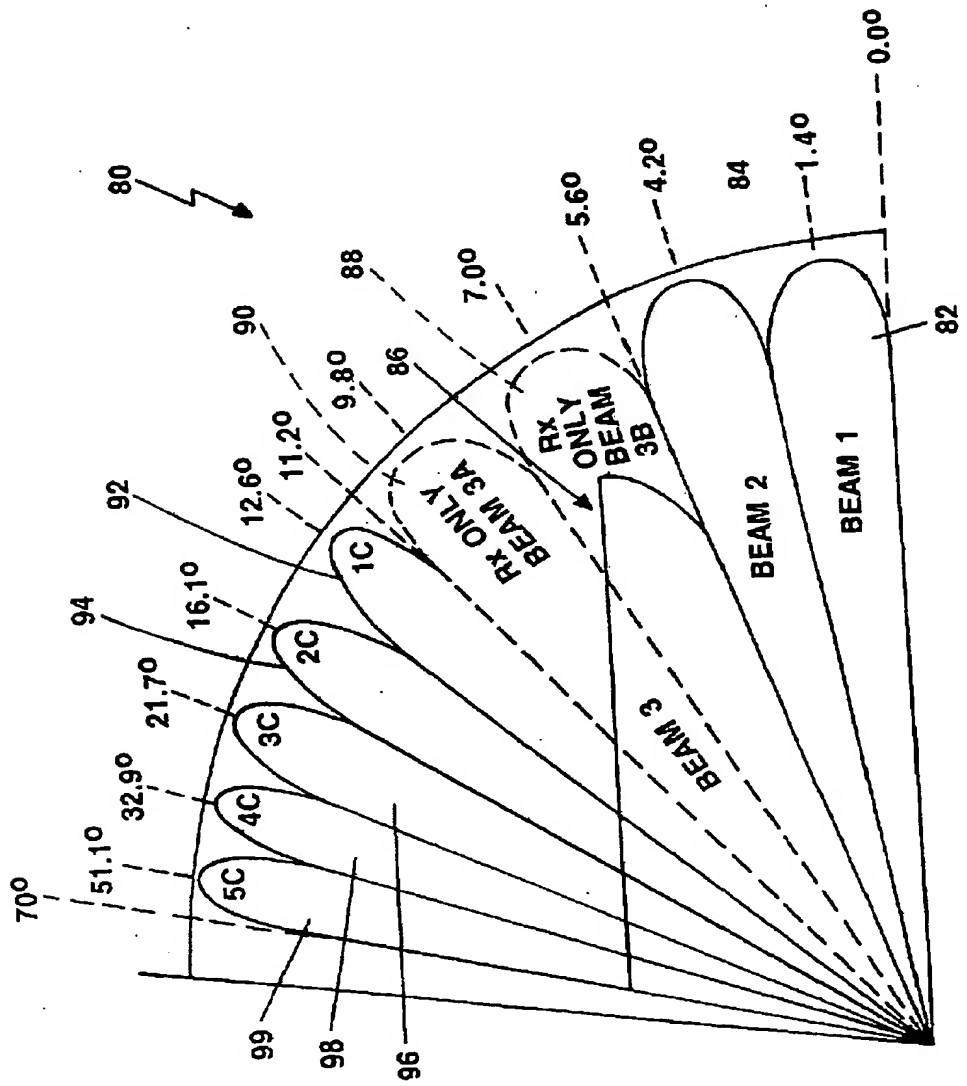
80
88
90
92
94
70°
51.1°
32.9°
21.7°
16.1°
12.6°
11.2°
9.8°
7.0°
5.6°
4.2°
1.4°
0.0°
84
82
86
1C
2C
3C
4C
5C
99
98
96
Rx ONLY BEAM 3A
RX ONLY BEAM 3B
BEAM 3
BEAM 2
BEAM 1

FIG. 2

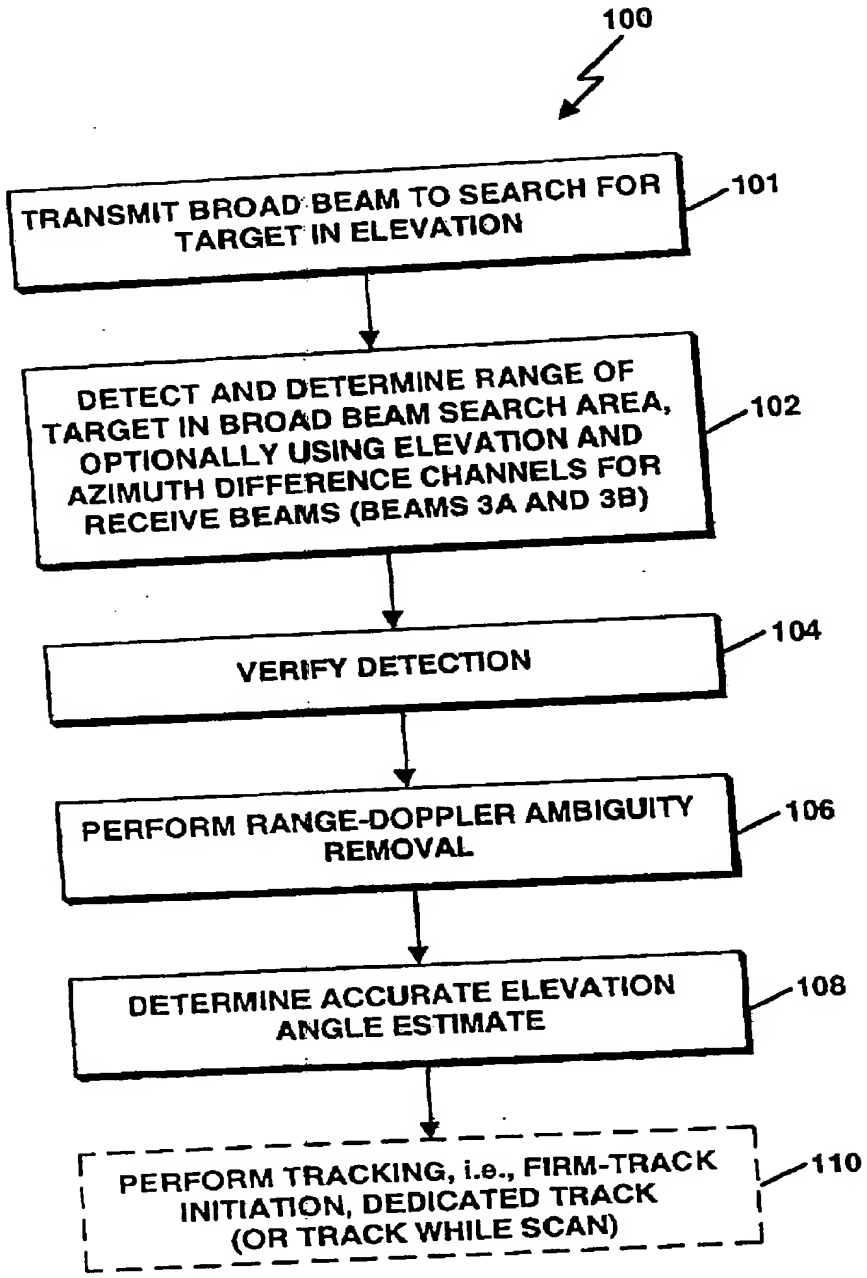
100
TRANSMIT BROAD BEAM TO SEARCH FOR TARGET IN ELEVATION
101
DETECT AND DETERMINE RANGE OF TARGET IN BROAD BEAM SEARCH AREA, OPTIONALLY USING ELEVATION AND AZIMUTH DIFFERENCE CHANNELS FOR RECEIVE BEAMS (BEAMS 3A AND 3B)
102
VERIFY DETECTION
104
PERFORM RANGE-DOPPLER AMBIGUITY REMOVAL
106
DETERMINE ACCURATE ELEVATION ANGLE ESTIMATE
108
PERFORM TRACKING, i.e., FIRM-TRACK INITIATION, DEDICATED TRACK (OR TRACK WHILE SCAN)
110

FIG. 3

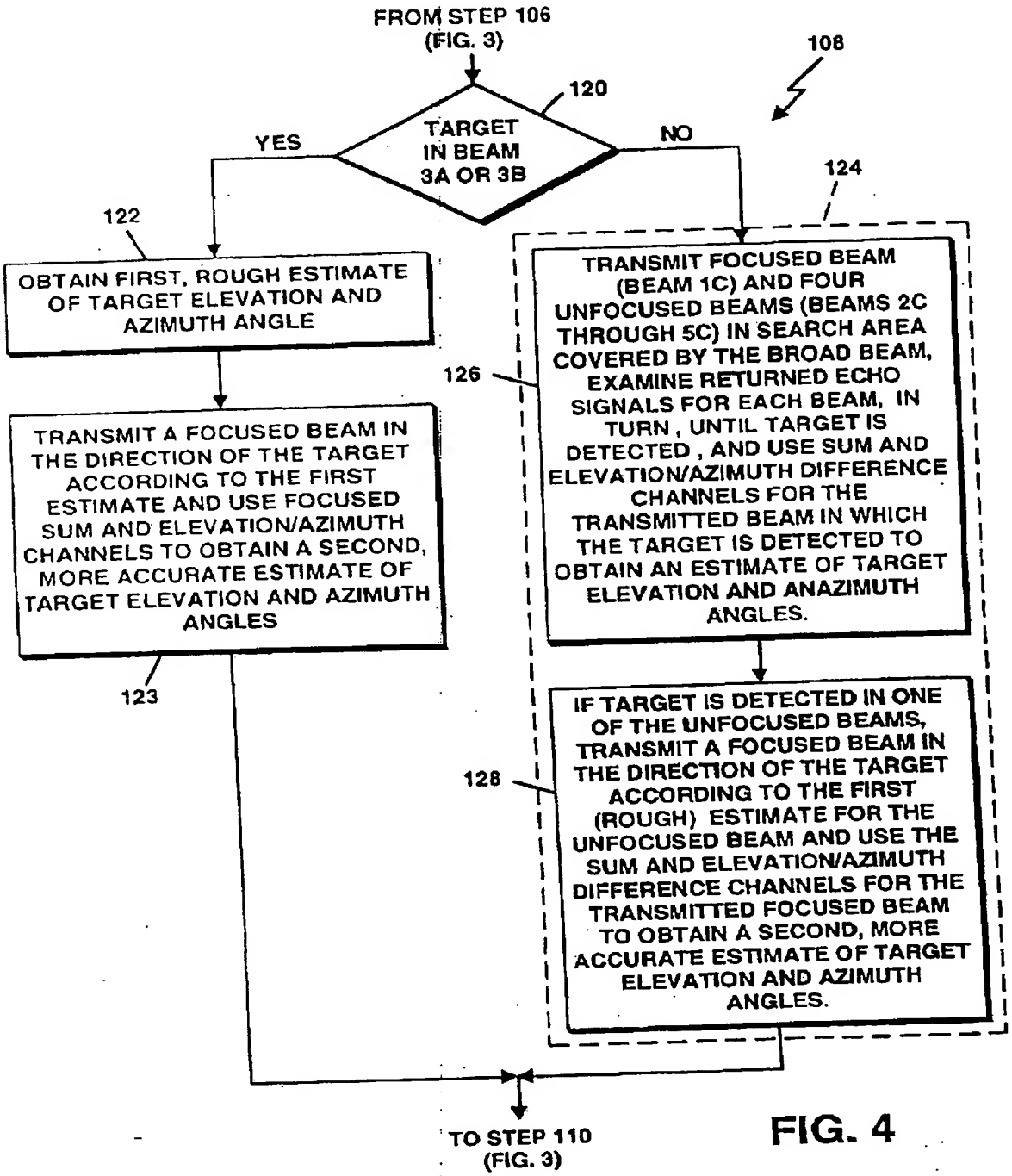
FROM STEP 106
(FIG. 3)
108
120
TARGET IN BEAM 3A OR 3B
YES
NO
124
122
OBTAIN FIRST, ROUGH ESTIMATE OF TARGET ELEVATION AND AZIMUTH ANGLE
TRANSMIT FOCUSED BEAM (BEAM 1C) AND FOUR UNFOCUSED BEAMS (BEAMS 2C THROUGH 5C) IN SEARCH AREA COVERED BY THE BROAD BEAM, EXAMINE RETURNED ECHO SIGNALS FOR EACH BEAM, IN TURN, UNTIL TARGET IS DETECTED, AND USE SUM AND ELEVATION/AZIMUTH DIFFERENCE CHANNELS FOR THE TRANSMITTED BEAM IN WHICH THE TARGET IS DETECTED TO OBTAIN AN ESTIMATE OF TARGET ELEVATION AND ANAZIMUTH ANGLES.
126
TRANSMIT A FOCUSED BEAM IN THE DIRECTION OF THE TARGET ACCORDING TO THE FIRST ESTIMATE AND USE FOCUSED SUM AND ELEVATION/AZIMUTH CHANNELS TO OBTAIN A SECOND, MORE ACCURATE ESTIMATE OF TARGET ELEVATION AND AZIMUTH ANGLES
123
IF TARGET IS DETECTED IN ONE OF THE UNFOCUSED BEAMS, TRANSMIT A FOCUSED BEAM IN THE DIRECTION OF THE TARGET ACCORDING TO THE FIRST (ROUGH) ESTIMATE FOR THE UNFOCUSED BEAM AND USE THE SUM AND ELEVATION/AZIMUTH DIFFERENCE CHANNELS FOR THE TRANSMITTED FOCUSED BEAM TO OBTAIN A SECOND, MORE ACCURATE ESTIMATE OF TARGET ELEVATION AND AZIMUTH ANGLES.
128
TO STEP 110
(FIG. 3)

FIG. 4

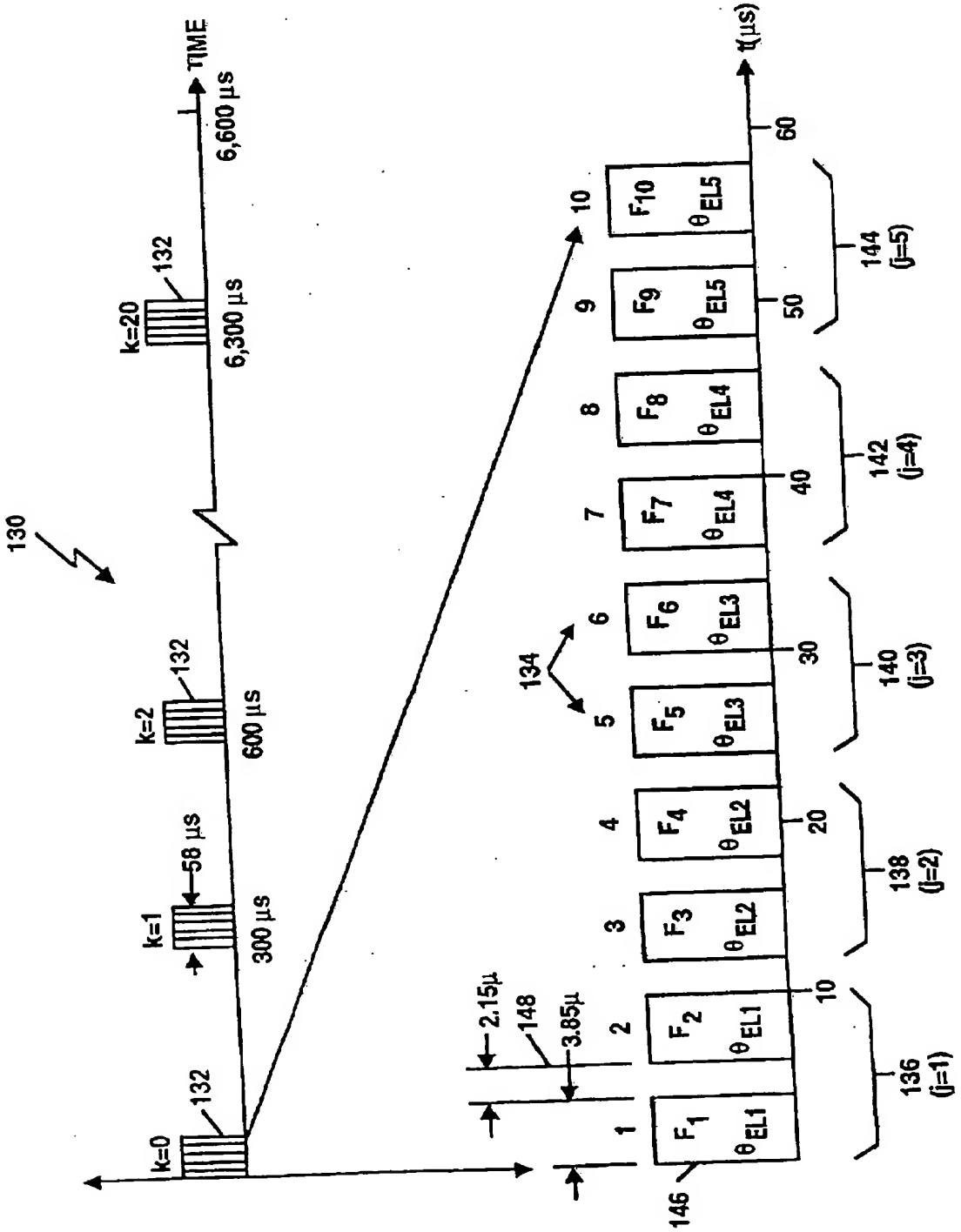
TIME
6,600 µs
6,300 µs
600 µs
300 µs
58 µs
k=20
k=2
k=1
k=0
132
130
134
t(µs)
60
50
40
30
20
10
2.15µ
3.85µ
148
146
F10 θEL5
F9 θEL5
F8 θEL4
F7 θEL4
F6 θEL3
F5 θEL3
F4 θEL2
F3 θEL2
F2 θEL1
F1 θEL1
144 (j=5)
142 (j=4)
140 (j=3)
138 (j=2)
136 (j=1)

FIG. 5

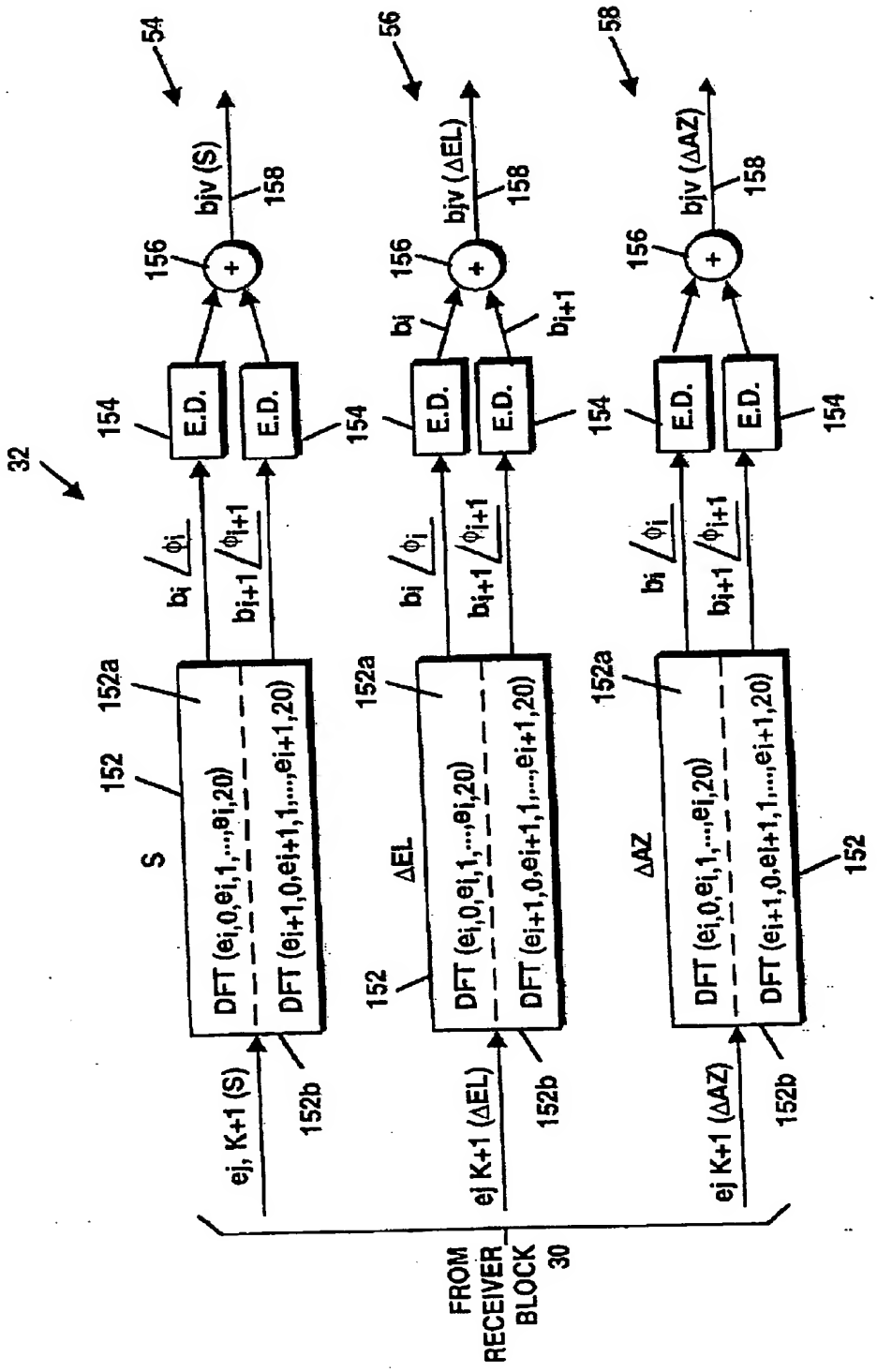
54
56
58
32
bjv (S)
bjv (ΔEL)
bjv (ΔAZ)
158
156
154
E.D.
bi ∠φi
bi+1 ∠φi+1
152a
152
S
ΔEL
ΔAZ
DFT (ei,0,ei,1,...,ei,20)
DFT (ei+1,0,ei+1,1,...,ei+1,20)
ej, K+1 (S)
ej K+1 (ΔEL)
ej K+1 (ΔAZ)
152b
FROM RECEIVER BLOCK 30

FIG. 6

"EFFICIENT TECHNIQUE FOR ESTIMATING ELEVATION ANGLE WHEN USING A BROAD BEAM FOR SEARCH IN A RADAR
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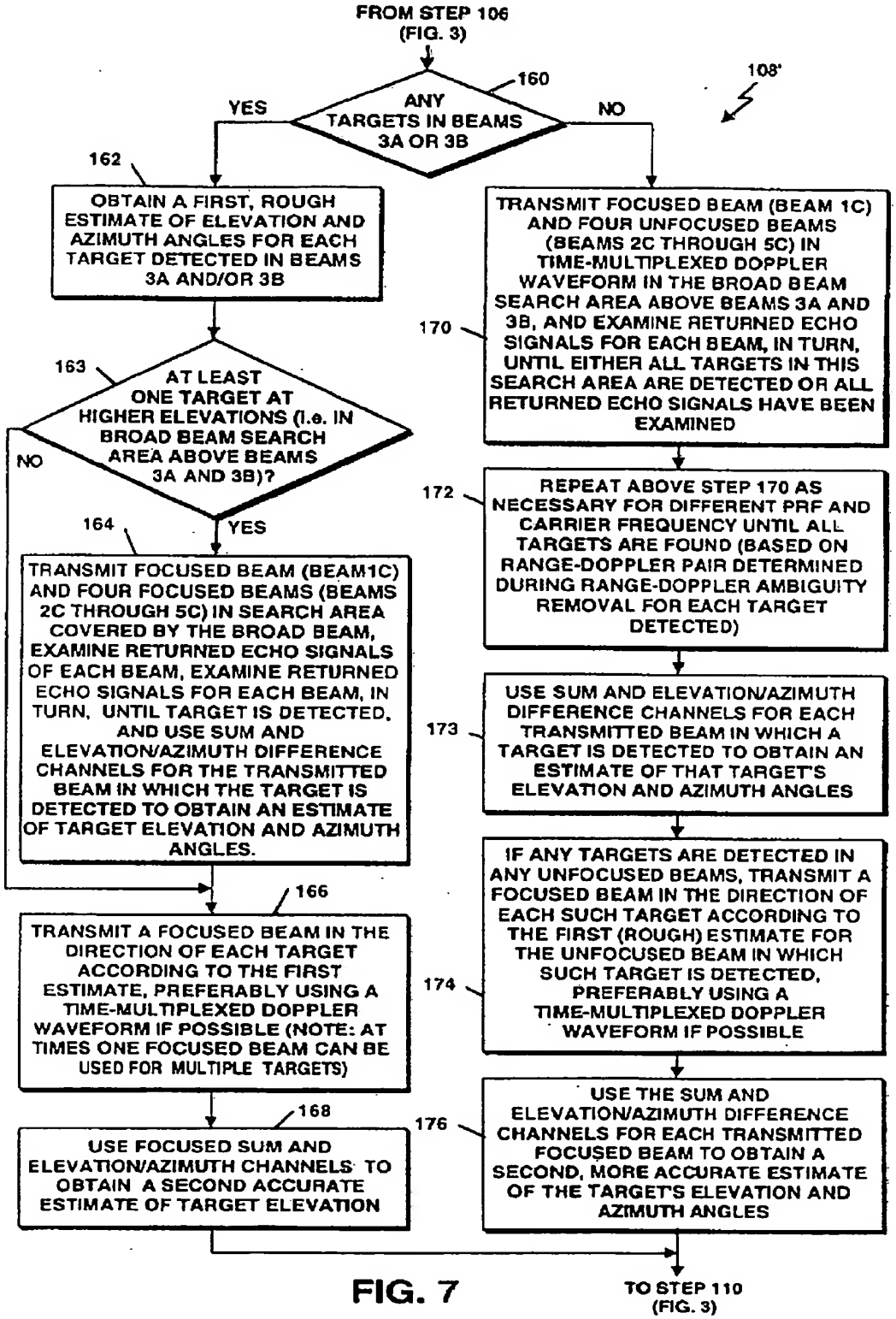

FIG. 7

MULTIPLE RADAR COMBINING FOR INCREASED RANGE, RADAR SENSITIVITY AND ANGLE ACCU Y
Eli Brookner et al.
Application No. 10/684,081

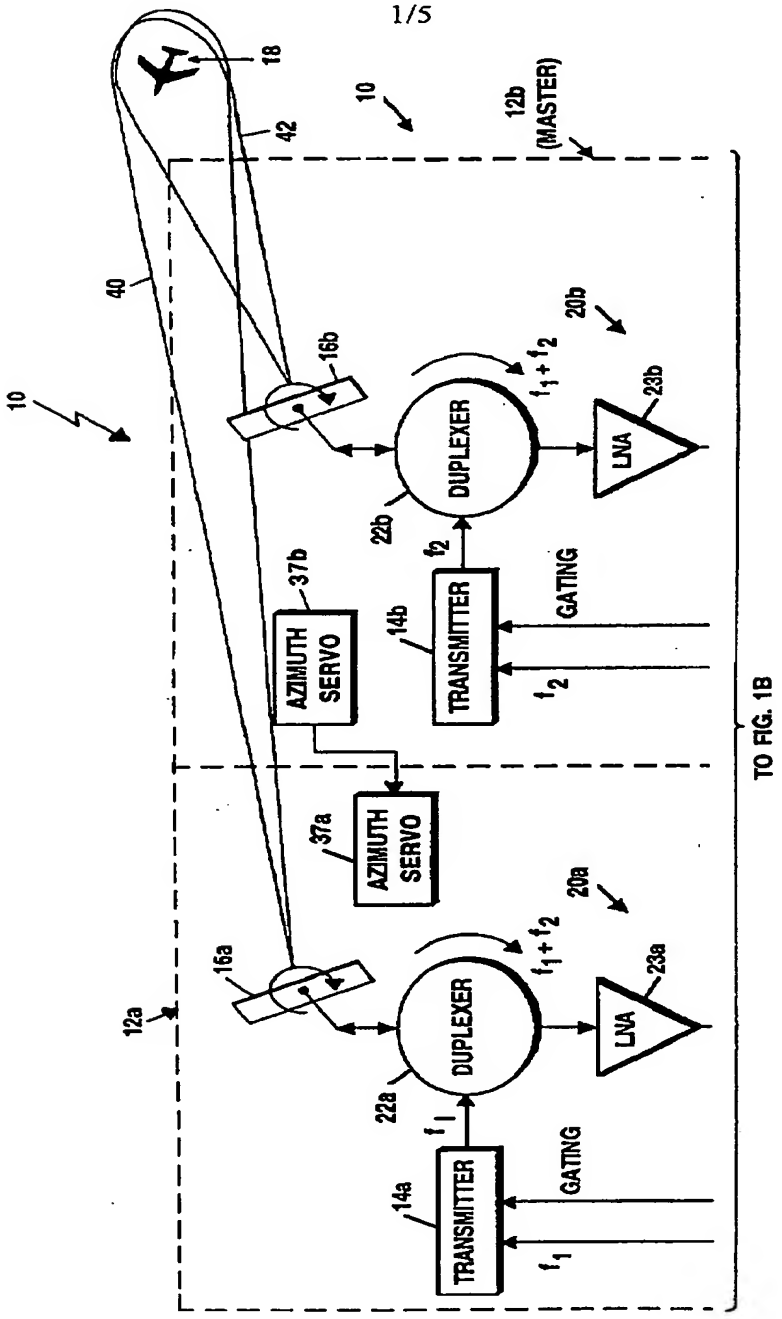

FIG. 1A

EP 0 509 843 A2

coverage. Beams at higher elevation angles transmit pulse widths which are shorter than beams at low elevation angles, so that the minimum range requirement is met without a second scan, which also reduces the time required for volumetric scan. The number of pulses which are integrated to produce a return increases off-axis, to restore system margin lost due to off-axis power gain reduction. The volumetric scan rate is increased by a dynamic

FIG. 2a